Patent Claims

1. A device (17) for detecting an analyte in a liquid having a multiplicity of electrodes (15) that are insulated from one another and are arranged on a first side (12) of an electrically nonconductive plate (10) that is impermeable to the liquid, the electrodes (15), at least in part, having an analyte-specific coating or analyte-specific molecules and being able to be electrically contact-connected and individually conducted out from a second side (14) of the plate by means of electrical conductors extending through the plate (10), the coating or the molecules being analyte-specific by virtue of having a specific affinity for the analyte or a substance formed owing to the presence of the analyte, and the device having no outgoing lines.

2. The device (17) as claimed in claim 1, the electrical conductors being formed in one piece together with the electrodes (15).

3. The device (17) as claimed in one of the preceding claims, the coating or the analyte-specific molecules at the electrodes (15) in each case being different.

4. The device (17) as claimed in one of the preceding claims, the coating or the analyte-specific molecules comprising, in particular electrochemically inert, capture molecules.

5. The device (17) as claimed in claim 4, the capture molecules being, in particular single-stranded, nucleic acids, nucleic acid analogs, ligands, haptens, peptides, proteins, sugars, lipids or ion exchangers.

6. The device (17) as claimed in claim 4 or 5, the capture molecules being covalently and/or directionally

bound to the electrodes (15).

7. The device (17) as claimed in one of claims 4 to 6, the capture molecules, at least in part, being bound to the electrodes (15) by means of an, in particular electrochemically largely inert, intermediate layer.

8. The device (17) as claimed in claim 7, the intermediate layer being formed from silane.

9. The device (17) as claimed in one of the preceding claims, the coating comprising at least one semipermeable covering of the electrodes (15).

10. The device (17) as claimed in claim 9, the semipermeable coverings in each case having a different permeability.

11. The device (17) as claimed in one of the preceding claims, the electrical conductors being arranged in perforations (22) of the plate (10) which taper from the second side (14) of the plate (10), in particular conically, toward the first side (12).

12. The device (17) as claimed in one of the preceding claims, the plate (10) being arranged on the bottom of a microfluid chamber (42) or forming the bottom of a microfluid chamber.

13. The device (17) as claimed in one of the preceding claims, the plate (10) being a chip.

14. The device (17) as claimed in one of the preceding claims, the plate (10) having more than 10, preferably more than 20, 40, 80, 100 or 160, particularly preferably more than 1000, especially more than 10,000 electrodes per cm^2.

15. The device (17) as claimed in one of the preceding claims, the electrodes (15), at least in part, being formed from particles.

16. The device (17) as claimed in one of the preceding claims, the electrodes (15), at least in part, being formed from a non-metallic conductor, in particular carbon.

17. The device (17) as claimed in claim 16, the electrodes (15), at least in part, being pencil, glassy carbon, carbon fiber containing, carbon paste or plastic composite electrodes, preferably polycarbonate electrodes containing elementary carbon, in particular in the form of graphite or carbon black.

18. A measuring device, comprising a device (17) as claimed in one of the preceding claims, in which the electrodes (15) comprise at least one reference electrode and at least one counterelectrode and also a multiplicity of working electrodes, the measuring device containing current/voltage converters, a potentiostat and a means for measuring the currents flowing through the working electrodes, and the electrodes (15) being electrically connected to the potentiostat for generating a predetermined voltage profile between the working electrodes and the reference electrode, one of the current/voltage converters being connected downstream of each of the working electrodes in order to hold all the working electrodes at the same potential.

19. A method for producing a device (17) as claimed in one of claims 1 to 17 having the following steps of:

a) producing a composite of elongate electrode material (15) that is essentially arranged parallel and insulating material surrounding the electrode material

(15), the composite being produced by means of

- encapsulating a solid electrode material (15) with a curing insulating material,

- introducing a solid electrode material (15) into essentially parallel cut-outs or perforations (22) of a solid insulating material or into a plastically deformable insulating material,

- filling pasty or liquid curing electrode material (15) into essentially parallel cut-outs or perforations (22) of a solid one-piece insulating material or of a stacked plate-type insulating material with congruently arranged perforations (22),

- connecting electrode material (15), having a sheathing (18) comprising insulating material, by melting, potting or adhesively bonding the sheathing (18), or

- extruding a composite made of electrode material (15) surrounded by insulating material (18),

and

b) separating the composite essentially perpendicularly to the longitudinal direction of the electrode material (15) by cutting, sawing or by means of a separating disk or by taking apart the stacked plate-type insulating material.

20. A method for producing a device (17) as claimed in one of claims 1 to 17 having the following steps of:

a) providing an electrically nonconductive plate (10) with perforations (22),

b) applying a pasty curing electrode material (15) to

a first side (12) of the plate (10),

c) pressing the electrode material (15) into the perforations (22), and

d) removing the electrode material (15) present between the perforations (22) in so far as said electrode material (15) electrically conductively connects the electrode material (15) present in the perforations.

21. A method for producing a device (17) as claimed in one of claims 1 to 17 having the following steps of:

a) providing an electrically nonconductive plate (10) with perforations (22),

b) placing an aperture mask (24) having holes (26) that correspond to the perforations (22), at least in part, or a screen printing mask having permeable areas that correspond to the perforations, at least in part, onto the first side (12) of the plate (10) such that the holes (26) or the areas are congruent, at least in part, with the perforations (22) of the plate (10),

c) applying a pasty curing electrode material (15) to the aperture mask (24) or screen printing mask,

d) pressing the electrode material (15) into the perforations (22) by way of the holes or permeable areas, and

e) removing the aperture mask (24) or screen printing mask from the plate (10).

22. A method for producing a device (17) as claimed in one of claims 1 to 17, having the following steps of:

a) providing an electrically nonconductive plate (10),

b) producing perforations in the plate (10),

c) producing vias in the perforations for producing the electrical conductor extending through the plate (10) and

d) applying a pasty curing electrode material (15) to the vias on the first side (12) of the plate (10).

23. The method as claimed in claim 22, in step ref. b the perforations being produced by boring, in particular by means of a laser beam.

24. The method as claimed in claim 22 or 23, in step ref. c the vias being produced by electrodeposition in the perforations or by introducing a respective conductor into the perforations.

25. The method as claimed in one of claims 22 to 24, the electrode material being applied by means of pad printing or a method like screen printing.

26. The method as claimed in one of claims 19 to 25, an analyte-specific coating being applied to the electrode material (15) or analyte-specific molecules being introduced into the electrode material (15).

27. The method as claimed in claim 26, capture molecules, in particular electrochemically inert capture molecules, being applied or introduced as coating or analyte-specific molecules.

28. The method as claimed in claim 26 or 27, in each case different coatings being applied to the electrode material (15) or in each case different

analyte-specific molecules being introduced into the electrode material (15).

29. The method as claimed in one of claims 26 to 28, the capture molecules used being, in particular single-stranded, nucleic acids, nucleic acid analogs, ligands, haptens, peptides, proteins, sugars, lipids or ion exchangers.

30. The method as claimed in one of claims 26 to 29, the capture molecules being covalently and/or directionally bound to the electrode material (15) or being synthesized or electrochemically deposited on the electrode material (15).

31. The method as claimed in one of claims 26 to 30, the capture molecules, at least in part, being bound to the electrode material (15) by means of an, in particular electrochemically largely inert, intermediate layer or being synthesized on the intermediate layer.

32. The method as claimed in claim 31, the intermediate layer being formed from silane.

33. The method as claimed in one of claims 19 to 32, the electrode material (15) being coated with at least one semipermeable covering.

34. The method as claimed in claim 33, the electrode material (15) in each case being coated with semipermeable coverings having different permeability.

35. A method for electrically contact-connecting a device (17) as claimed in one of claims 1 to 17, a plurality of electrical conductors (30) that can be individually conducted out being brought into contact with the second side (14) of the plate (10) of the

device (17) such that the conductors (30) in this case, at least in part, contact-connect the electrodes (15) such that the electrodes (15) can be individually electrically conducted out.

36. The method as claimed in claim 35, the conductors (30) being mounted in a manner enabling spring deflection and being brought into contact with the second side (14) of the plate (10) such that they effect spring deflection in this case.

37. The method as claimed in claim 35, the electrical contact-connection being effected by means of an elastomeric connector, in particular a ZEBRA® elastomeric connector.

38. The use of a device (17) as claimed in one of claims 1 to 17 for detecting at least one analyte in a liquid, the liquid being brought into contact with electrodes (15) on the first side (12) of the plate (10) of the device (17) and the electrodes (15) being electrically contact-connected from the second side (14) of said plate.

39. The use as claimed in claim 38, the liquid being brought into contact with the electrodes (15) under conditions under which the analyte or a substance formed owing to the presence of the analyte binds to capture molecules present at the electrodes (15) and the analyte bound to the capture molecules or the substance bound thereto is detected electrically, electrochemically, optically, photoelectrically, enzymatically, by means of electroluminescence or by means of chemiluminescence or by means of a combination thereof.

40. The use as claimed in claim 38 or 39, at least one electrode (15) being coated with a semipermeable

covering and selectively only such analytes, decomposition products of analytes or substances which penetrate the covering being detected electrically, electrochemically, optically, photoelectrically, enzymatically, by means of electroluminescence or by means of chemiluminescence or by means of a combination thereof.

41. The use as claimed in one of claims 38 to 40, the analyte being a biomolecule, in particular a nucleic acid, a protein, an antigen, a sugar, a lipid, a cell or a virus.

42. The use as claimed in one of claims 38 to 41, the analyte having a labelling substance.

43. The use as claimed in one of claims 38 to 42, a redox reaction or a catalytic evolution of hydrogen being detected electrochemically.

44. The use as claimed in one of claims 38 to 43, the electrochemical detection being effected by means of differential pulse voltammetry (DPV), chronopotentiometric stripping analysis (CPSA) or detection of a change in resistance or impedance.

45. The use as claimed in one of claims 38 to 44, the electrochemical detection comprising the following steps of:

a) providing a device (17) as claimed in one of claims 1 to 17, the device (17) having at least one counterelectrode and a reference electrode and also a multiplicity of working electrodes,

b) bringing the liquid into contact with the working, counter- and reference electrodes,

c) simultaneously applying a predetermined voltage profile between the working electrodes and the reference electrode, and

d) measuring the currents flowing through the working electrodes, all the working electrodes being held at the same potential during measurement.

46. The use as claimed in one of claims 38 to 45, a potential interval in which essentially only the analyte or the substance causes a signal being chosen for measurement for the electrochemical detection.

47. The use as claimed in one of claims 38 to 46, the, in particular carbon containing, electrodes (15) being treated with a detergent prior to the detection of the analyte.

48. The use as claimed in claim 47, the detergent being an ionic detergent.

49. The use as claimed in claim 47 or 48, the detergent being present in a concentration of 0.1% w/v to 10% w/v.

50. The use as claimed in one of claims 47 to 49, the detergent having a critical micellar concentration of less than 10 mmol/l, in particular less than 5 mmol/l, preferably less than 3 mmol/l, in water.

51. The use as claimed in one of claims 47 to 50, the detergent being sodium dodecyl sulfate.